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**PROCESS FLOWCHARTS
AND
PROCESS DESCRIPTION**

During gallium/germanium processing by St. George Mining

Attachment E

Information Request #3

4.0 PROCESSING FACILITY

4.1 General

The mill and existing waste disposal ponds are located 12 miles west of St. George, Utah, and 0.5 miles south of State Highway 91. The site shown on Figure 2 lies in a broad valley at an elevation of about 3,700 ft.

The processing plant and disposal facilities are located on the eastern slope of the Beaver Dam Mountains at the head of a small catchment. About 100 acres will be affected by the processing facility, including 15 acres of the mill and 85 acres for the tailings disposal ponds and related structures. The existing and proposed facilities layout is shown on Figure 9.

The Apex Mine is designed as a 100 tpd operation and will process about 312,000 tons during the 13 year mine life. The processing will operate 24 hours per day and five days per week. The mining and processing operations are scheduled to begin in the second quarter of 1990.

4.2 Extraction Process - TO BE REVISED

In the new process, the ore will be delivered to the plant by truck and stored in a run-of-mine stockpile about 250 x 250 ft in size. The ore will be delivered in a moistened form to control fugitive dust emissions. Ore from the stock pile will be transferred by front-end loader into a hopper and stored in a fine ore bin. The ore will then be fed into a ball mill and wet-ground to 35 mesh.

The ground ore will be leached in three countercurrent stages at 80°C with sulfuric acid, sodium chloride, and sulfur dioxide. The pregnant leach solution will contain about 20 g/L chloride at a pH < 1.0. The leached residue will be washed in three countercurrent

decantation stages with a barren recycle solution, obtained from the zinc thickener overflow.

Copper will be precipitated from the leach solution by adding iron powder in three stages. The majority of the soluble lead and arsenic are precipitated with the copper. The chloride levels in the concentrated discharge are further increased to three molar by the addition of sodium chloride. The gallium and zinc are extracted by a tertiary amine and solvent, and stripped by dilute sulfurous acid. The sulfurous acid is a by-product of the sulfur dioxide generation process. The product strip solution will contain gallium, zinc, and a small quantity of iron. The three metals are then separated by a differential precipitation process. Gallium is precipitated first by adjustment of the solution pH to 5.0. The iron is then precipitated through oxidation at a pH of 4.0. Finally, the zinc is precipitated by raising the pH of 7.5 using ammonia and sodium carbonate or soda ash.

The germanium in the solvent extraction raffinate is precipitated by the addition of hydrogen sulfide to form a low grade precipitate. The precipitate is dissolved in an oxidizing hydrochloric acid leach, using sodium chlorate as the oxidant. The germanium is solubilized as a chloride, which is distilled from the pulp by heating to 104°C. The germanium in the distillate is hydrolyzed by neutralization with ammonia, forming germanium hydroxide and oxychloride. A simplified flowsheet of the process is presented on Figure ____.

The process will generate approximately 806 tons/year of cement copper, 980 tons/year of zinc hydroxide, 61 tons/year of a 32 percent germanium concentrate, and 44 tons/year of a 25 percent gallium concentrate. The cement copper and zinc hydroxide will be spread onto concrete pads and air dried to ten percent moisture.

The dried product will be loaded into enclosed containers and shipped to a copper/zinc smelter for final processing. Minor quantities of silver can be recovered from the off-site processing of the copper. The gallium and germanium will be loaded into 55-gallon plastic-lined drums. The drums will be sealed and shipped by truck for processing after accumulation of a full load.

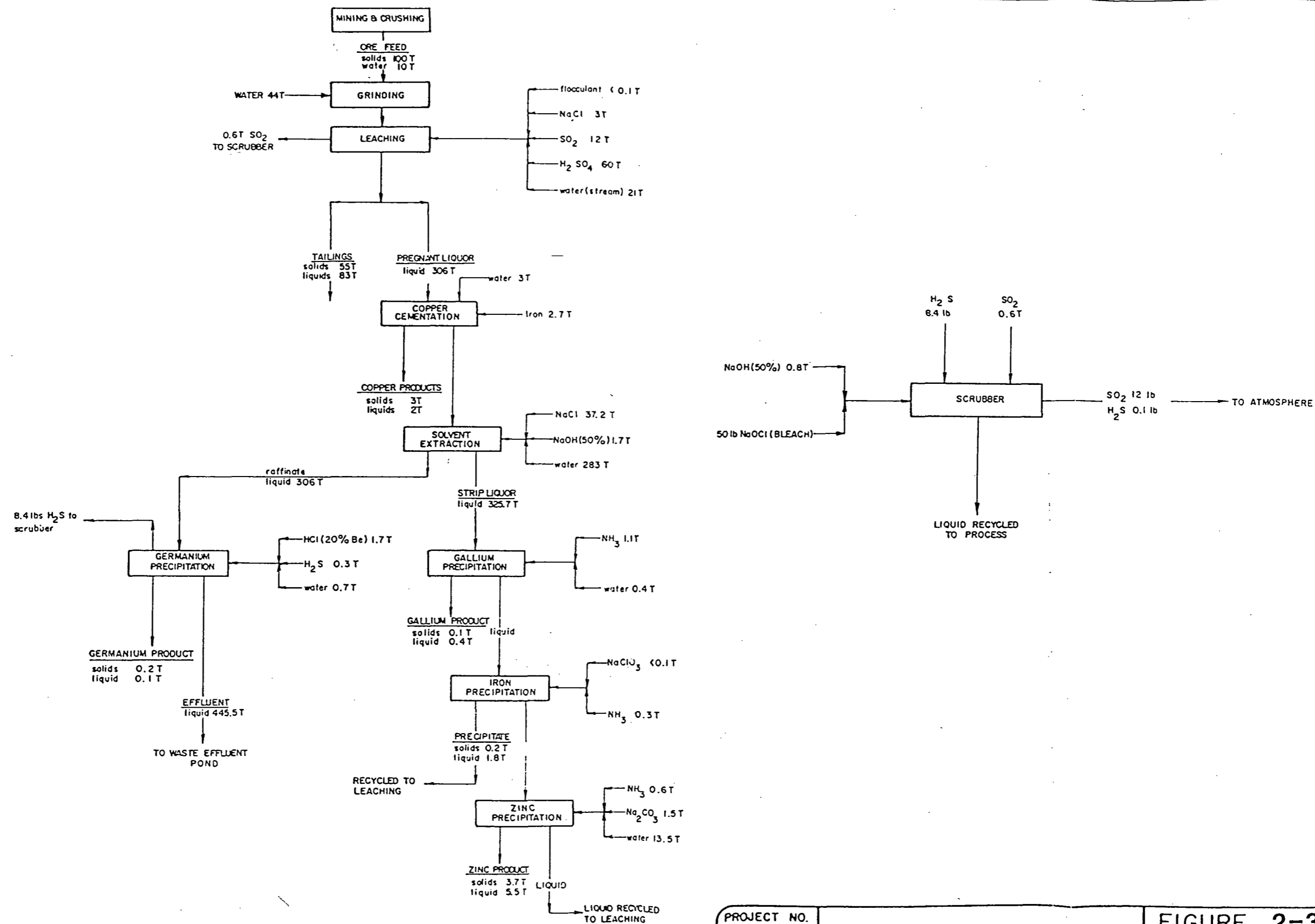
The chemicals utilized as reagents in the processing of the ore are listed in Table 2 and include acids, bases, ammonia, hydrogen sulfide, iron, sulfur, flocculents, kerosene, an alcohol, and other extraction solvents. The on-site storage of chemicals is designed for a minimum of ten days. All chemical storage and handling is designed to comply with Department of Transportation, OSHA, and MSHA regulations, and to follow guidelines provided by the manufacturing Chemists Association and the National Tank Truck Carriers. Employees handling the reagents will be given extensive training in the safe use and handling of potentially hazardous materials.

4.3 Existing Wastes

4.3.1 General

A variety of chemicals and processes were employed in the production of copper, zinc, gallium, and germanium. The processing yielded two individual waste streams; a leach tails and a raffinate. Both were characterized by low pH, high acidity, elevated metals levels, and total dissolved solids concentrations. The proposed treatment of the two waste streams involved lime neutralization to a basic pH to facilitate precipitation of the metals, followed by disposal of the neutralized slurries in lined waste disposal ponds.

The slurries once disposed of in the ponds were to consolidate further through evaporation. The degree of drying



PROJECT NO.	ST GEORGE MINING CORPORATION	FIGURE 2-3 GENERAL PROCESS FLOW SHEET & MATERIAL BALANCE
FUNCTION NO.		
REVISION NO.		